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Revision 2
February 2003

U.S. Department of Energy
Idaho Operations Office

Field Sampling Plan for Operable Unit 3-13, Group 4, Perched Water Well Installation

INEEL
Home of Science
and Engineering Solutions
Idaho National Engineering and Environmental Laboratory

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ABSTRACT

This Field Sampling Plan describes the drilling and sampling activities that will be conducted in preparation for the installation of vadose zone instrumentation and monitoring wells and tracer testing at the Idaho Nuclear Technology and Engineering Center. This equipment installation covers Phase I of the Operable Unit 3-13, Group 4 (Perched Water) remedial design/remedial actions. The purpose of this Field Sampling Plan is to present the rationale and methods for installation of the perched water wells. Also included are the installation of instrumentation and the associated sampling and analysis. Several new monitoring wells will be installed within the security fence at Idaho Nuclear Technology and Engineering Center. The locations were selected to meet the data quality objectives detailed in this plan. Data obtained from this drilling and sampling program will be used to evaluate the effectiveness of remedial design/remedial action activities identified in the Operable Unit 3-13 Record of Decision for Group 4.

NOTE: *The Field Sampling Plan discussions for Phase I activities were written in September 2000 (prior to Phase I well installations) and are retained in the original form. For details on the final methodology, results, and status of Phase I activities, refer to the Phase I Monitoring Well and Tracer Study Report (DOE-ID 2002a). This Field Sampling Plan revision focuses on the initial sampling effort for Phase II activities.*

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FIGURES

TABLES

ACRONYMS

AA	alternative action
ALARA	as low as reasonably achievable
amsl	above median sea level
BBWI	Bechtel BWXT Idaho, LLC
bgs	below ground surface
BLR	Big Lost River
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CoC	chain-of-custody
COC	contaminant of concern
CPP	Chemical Processing Plant
DOE	Department of Energy
DOE-ID	Department of Energy Idaho Operations Office
DOT	Department of Transportation
DQO	data quality objective
DR	decision rule
DS	decision statement
EPA	Environmental Protection Agency
ER	environmental restoration
ERIS	Environmental Restoration Information System
ES&H	environmental safety and health
ES&H/QA	environmental safety and health/quality assurance
FFA/CO	Federal Facility Agreement and Consent Order
FSP	Field Sampling Plan
FTL	field team leader
FUM	facilities, utilities, and maintenance
HASP	Health and Safety Plan

HSO	health and safety officer
IDEQ	Idaho Department of Environmental Quality
IEDMS	Integrated Environmental Data Management System
IH	industrial hygienist
INEEL	Idaho National Engineering and Environmental Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center
JRC	job requirements checklist
JSS	job site supervisor
M&O	management and operation
MCL	maximum contaminant level
MSIP	Monitoring System Implementation Plan
NEPA	National Environmental Policy Act
NIOSH	National Institute of Occupational Safety and Health
NOAA	National Oceanic and Atmospheric Administration
OMP	Occupational Medical Program
OSHA	Occupational Safety and Health Administration
OU	operable unit
PCE	tetrachloroethylene
PM	project manager
PPE	personal protective equipment
PSQ	primary study question
PVC	polyvinyl chloride
QA	quality assurance
QA/QC	quality assurance/quality control
QAPjP	Quality Assurance Project Plan
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RCT	radiological control technician
RD/RA	remedial design/remedial action

RG	Regulatory Guide
RI/FS	remedial investigation/feasibility study
ROD	Record of Decision
RPD	relative percent difference
RSD	relative standard deviation
S&H/QA	safety and health/quality assurance
SAM	Sample and Analysis Management
SAP	Sampling and Analysis Plan
SC	safety coordinator
SNF	spent nuclear fuel
SRPA	Snake River Plain Aquifer
STL	sample team lead
TAL	target analyte list
TCA	trichloroethane
TCE	trichloroethylene
TL	technical lead
USACE	United States Army Corps of Engineers
USGS	United States Geologic Survey
VOC	volatile organic compound
WAG	waste area group
WGS	Waste Generator Services
WMP	Waste Management Plan

Field Sampling Plan for Operable Unit 3-13, Group 4, Perched Water Well Installation

1. INTRODUCTION

The Idaho National Engineering and Environmental Laboratory (INEEL) is divided into 10 waste area groups (WAGs) to better manage environmental operations mandated under a Federal Facility Agreement and Consent Order (FFA/CO) (Department of Energy-Idaho Operations Office [DOE-ID] 1991). The Idaho Nuclear Technology and Engineering Center (INTEC), formerly the Idaho Chemical Processing Plant (CPP), is designated as WAG 3. Operable Unit (OU) 3-13 encompasses the entire INTEC facility.

Operable Unit 3-13 was investigated to identify potential contaminant releases and exposure pathways to the environment from individual sites as well as the cumulative effects of related sites. Ninety-nine release sites were identified in the OU 3-13 Remedial Investigation/Feasibility Study (RI/FS), of which, 46 were shown to have a potential risk to human health or the environment (DOE-ID 1997). A new operable unit, OU 3-14, was created to specifically address activities at the Tank Farm area where special actions will be required. The 46 sites were divided into seven groups based on similar media, contaminants of concern (COCs), accessibility, or geographic proximity. The OU 3-13 Record of Decision (ROD) (DOE-ID 1999) identifies remedial design/remedial action (RD/RA) objectives for each of the seven groups. The seven groups include

- Tank Farm Soils (Group 1)
- Soils Under Buildings and Structures (Group 2)
- Other Surface Soils (Group 3)
- Perched Water (Group 4)
- Snake River Plain Aquifer (SRPA) (Group 5)
- Buried Gas Cylinders (Group 6)
- SFE-20 Hot Waste Tank System (Group 7).

The final ROD for OU 3-13 was signed in October 1999 (DOE-ID 1999). This comprehensive ROD presents the selected remedial actions for the seven groups, including Group 4 perched water instrumentation to assess the perched water drain out and potential contaminant flux into the SRPA.

1.1 Project Purpose

NOTE: *The discussions for Phase I activities were written in September 2000 (prior to Phase I well installations) and are retained in their original form. For details on the final methodology, results, and status of Phase I activities, refer to the Phase I Monitoring Well and Tracer Study Report (DOE-ID 2002a).*

The purpose of this Field Sampling Plan (FSP) is to provide guidance for drilling, instrument installation, and collection of samples during the OU 3-13 Group 4 Perched Water remedial action at the

INTEC. Sampling and analysis activities addressed under this FSP include interbed sediment and groundwater sampling (all Phase I actions), performance of tracer test(s), and the initial round of Phase II groundwater sampling. Development of the FSP was based on the data requirements identified in the OU 3-13 ROD. This FSP includes

- Site description and background
- Data quality objectives (DQOs)
- Discussion of drilling methods and protocols
- Discussion of types of sampling to be conducted and the types of analyses to be performed
- Determination of sample locations and sampling frequency, based on available data (i.e., well construction/completion, historical water level data, historical water quality data, and other relevant considerations)
- Description of all field procedures to be used
- Sample control considerations
- Quality assurance (QA) requirements
- Project organization
- Waste management considerations
- Health and safety requirements.

This FSP is one of five documents that comprises the bulk of Monitoring System Implementation Plan (MSIP). The MSIP contains the Group 4 project documentation and includes, in addition to this FSP, the Long Term Monitoring Plan (DOE-ID 2000a), the tracer test plan (DOE-ID 2000b), the health and safety plan (HASP) (DOE-ID 2000c), and the Waste Management Plan (WMP) (DOE-ID 2000d).

1.2 Scope

The scope of this project is the installation of instrumentation to permit data collection on perched zone recharge sources and drain-out that will provide information necessary to meet the needs detailed in Section 8.1.4 of the OU 3-13 ROD. The ROD establishes two remediation goals for the perched water: (1) "reduce recharge to the perched water," and (2) "minimize migration of contaminants to the SRPA, so that SRPA groundwater outside of the current INTEC security fence meets the applicable State of Idaho groundwater standards by the year 2095" (DOE-ID 1999).

The primary activity for meeting these remediation goals is the relocation of the percolation ponds. If percolation pond relocation alone does not meet the requirements set forth in the ROD, then the ROD identifies a contingent remedy of limiting infiltration from the Big Lost River (BLR) through a lining program. The relocation of the percolation ponds and lining the BLR is outside the scope of this FSP. In addition, contamination associated with the tank farm surface soils and the injection well (CPP-23) residual source term will be addressed by OU 3-14.

Data needed to monitor these remedial actions will be gathered by instrumentation installed during the implementation of this FSP. A two-phased drilling approach will be utilized to maximize well and instrumentation placement. Phase I is to install wells and vadose zone instrumentation in the subsurface near three defined sources of recharge: (1) the percolation ponds (before they are relocated); (2) the BLR; and (3) the sewage treatment infiltration galleries. Phase I also includes the installation of wells and vadose zone instruments near the northwest corner of the tank farm and near the center of INTEC midway between the tank farm and percolation ponds. Phase II includes the drilling and instrument installation of up to nine additional wells surrounding the INTEC tank farm. If the contingent control of the BLR becomes necessary, an additional project, Phase III, may be developed. This FSP addresses Phase I and II actions required for monitoring the results of the percolation pond relocation and determining if this action meets the remediation goals. Figure 1-1 provides a logic diagram for Phase I and II activities.

1.3 Regulatory Background

The OU 3-13 ROD identified remedies for the seven contaminant groupings at INTEC, including the Perched Water. The remedial actions chosen in the ROD are in accordance with the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980 as amended by the Superfund Amendments and Reauthorization Act of CERCLA of 1986. In addition, the remedies comply with the National Oil and Hazardous Substances Pollution Contingency Plan (EPA 1990) and are intended to satisfy the requirements of the FFA/CO—Executive Order 12580.

The DOE-ID is the lead agency for remedy decisions. The Environmental Protection Agency (EPA) Region 10 and the Idaho Department of Environmental Quality (IDEQ) approve these decisions.

1.4 Document Organization

The organization of this FSP is as follows:

- INTEC description and background
- Project objectives
- Perched water well network and sampling/monitoring frequency
- Procedures
- Sample designation
- Project personnel
- Waste management
- Document control.

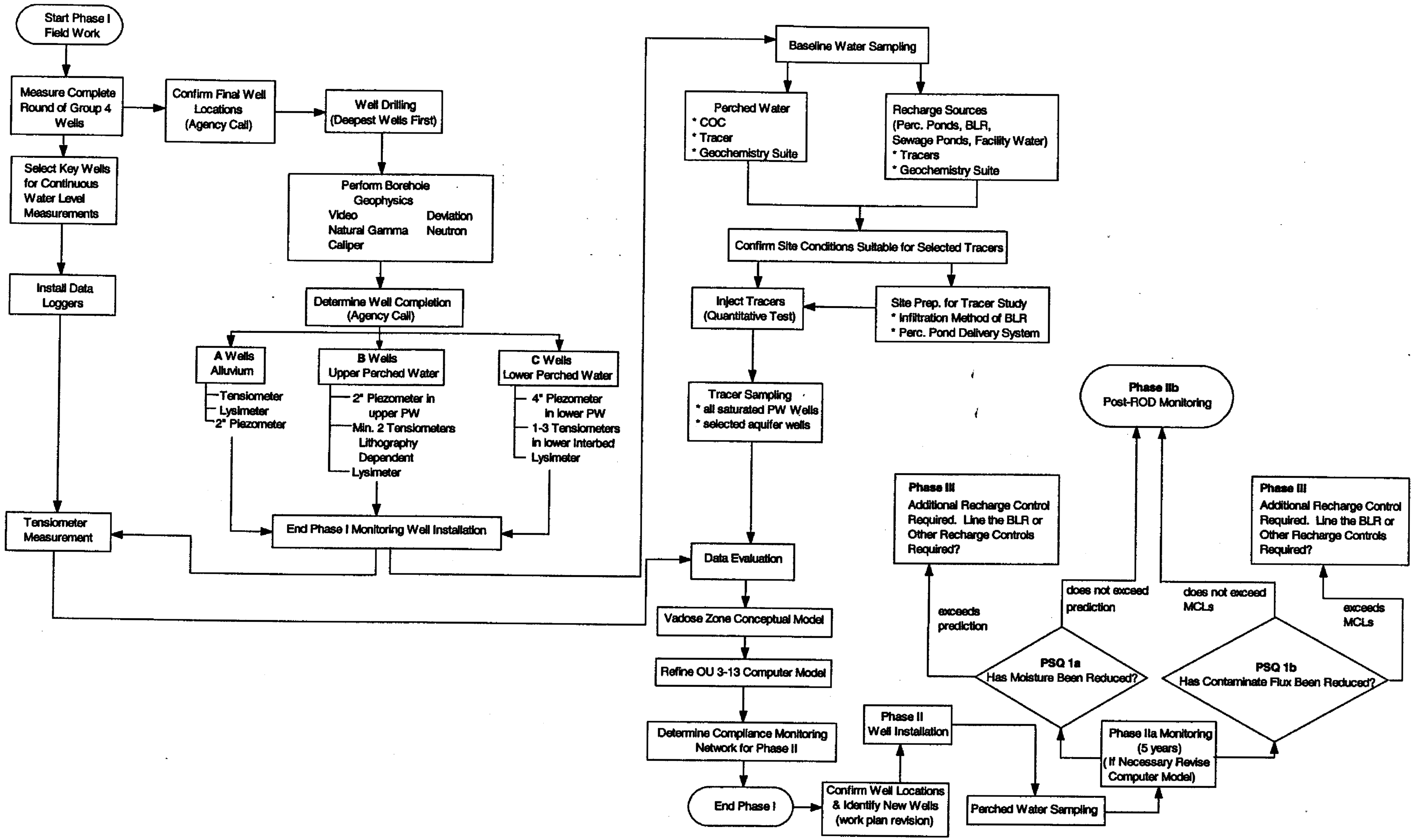

Figure 1-1. Logic diagram for Group 4 activities.

2. SITE DESCRIPTION AND BACKGROUND

The INEEL is a U.S. Government-owned facility managed by the United States Department of Energy (DOE). The eastern boundary of the INEEL is located 52 km (32 mi) west of Idaho Falls, Idaho. The INEEL Site occupies approximately 2,305 km2 (890 mi^2) of the northwestern portion of the Eastern Snake River Plain in southeast Idaho. The INTEC facility covers an area of approximately 0.39 km^2 (0.15 mi^2), and is located approximately 72.5 km (45 mi) from Idaho Falls, in the south-central area of the INEEL as shown in Figure 2-1.

INTEC has been in operation since 1952. The plant's original mission was to reprocess uranium from defense related projects, and research and store spent nuclear fuel (SNF). The DOE phased out the reprocessing operations in 1992 and redirected the plant's mission to (1) receipt and temporary storage of SNF and other radioactive wastes for future disposition, (2) management of current and past wastes, and (3) performance of remedial actions.

The liquid waste generated from the past reprocessing activities is stored in an underground tank farm. The INTEC tank farm consists of eleven 1,135,624 L (300,000 gal) tanks, four 113,562 L (30,000 gal) tanks, four 68,137 L (18,000 gal) tanks, and associated equipment for the monitoring and control of waste transfers and tank parameters. One of the 1,135,624 L (300,000 gal) tanks serves as a spare tank and is always kept empty in the event of an emergency. The majority of wastes stored in the tank farm are raffinates generated during the first-, second-, and third-cycle fuel extraction processes. These wastes include high-level wastes that are composed of first- and second-cycle raffinates and intermediate level wastes that are composed of third-cycle raffinates blended with concentrated bottoms from the process equipment waste evaporator. This liquid waste continues to be treated by a calcining process to convert the waste into a more stable form and to reduce the waste volume.

Numerous CERCLA sites are located in the area of the tank farm and adjacent to the process equipment waste evaporator. Contaminants found in the interstitial soils of the tank farm are the result of accidental releases and leaks from process piping, valve boxes, sumps, and cross-contamination from operations and maintenance excavations. No evidence has been found to indicate that the waste tanks themselves have leaked. The contaminated soils at the tank farm comprise about 95% of the known contaminant inventory at INTEC. The final comprehensive RI/FS for OU 3-13 (DOE-ID 1997) contains a complete discussion of the nature and extent of contamination.

The formulation of the perched water zone is a result of natural flows from the BLR and operations of the percolation ponds. The percolation ponds have come on line in a staggered manner. The pond directly south of the plant (Pond 1) began receiving service waste in 1984. The southeastern pond (Pond 2) came on line in 1986. The ponds have received all plant service wastewater since use of the injection well was discontinued in 1984. The ponds are filled on an annual alternating schedule. The two ponds received Resource Conservation and Recovery Act (RCRA) clean-closure equivalency for metals contamination in 1994 and 1995. This means that only the remaining radionuclides need to be addressed under CERCLA. Construction of new ponds to the west of the present facility are part of Group 4, Phase 1 activities under the 1999 ROD, but are outside the scope of this FSP.

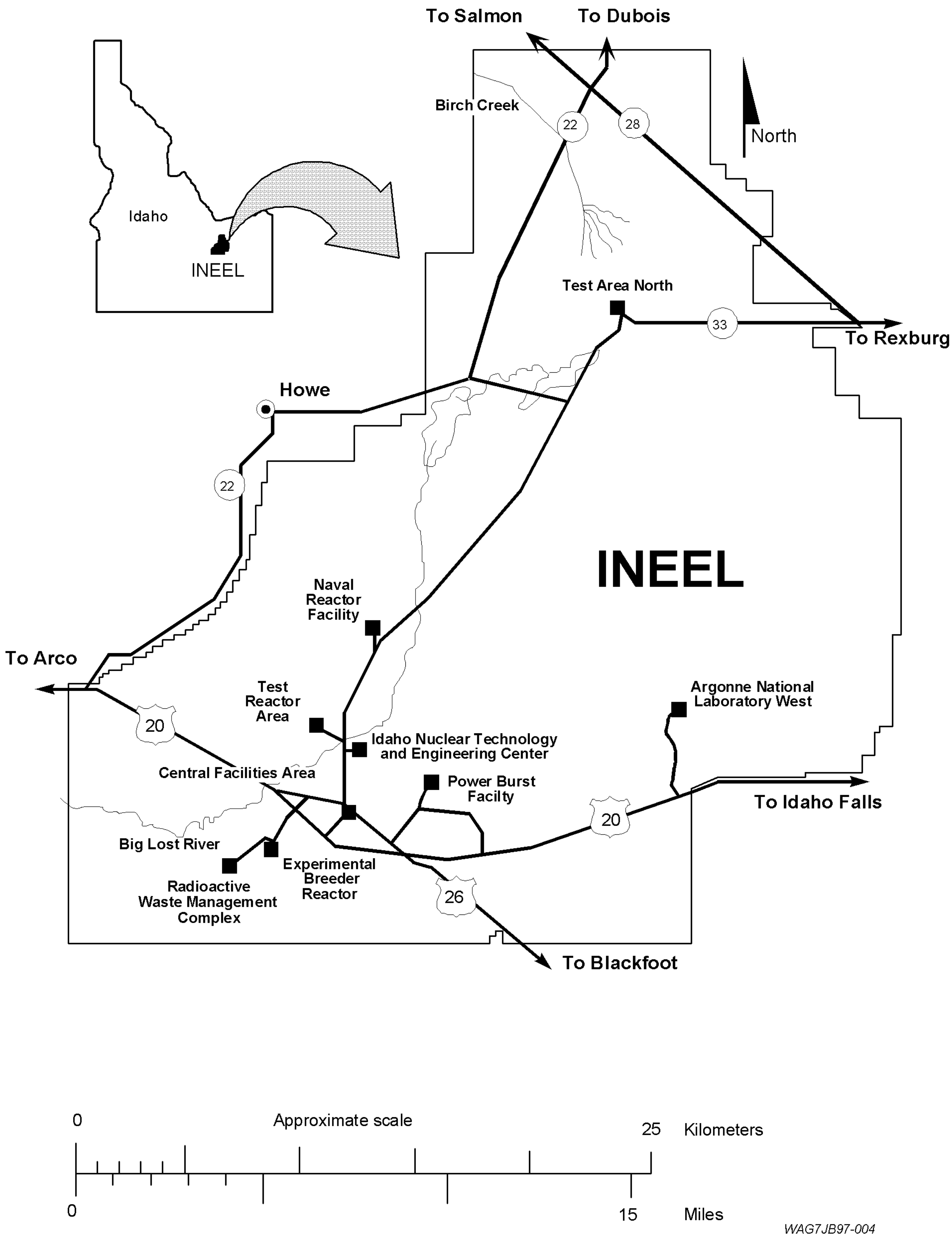

Figure 2-1. Map showing location of the INTEC at the INEEL.

2.1 Conceptual Model

Discussed below are the geologic and hydrologic settings surrounding the INTEC facilties.

2.1.1 Geologic Setting

The geology of the site includes about 13.7 m (45 ft) of surficial alluvium deposited by the BLR. The BLR is an intermittent stream, and flow is lost by infiltration through the riverbed. Underneath the alluvium are several thousand feet of relatively thin fractured basalt flows. Interspersed between some of the basalt flows are sedimentary interbeds ranging in thickness from a few inches to many feet. Some of the interbeds are fairly continuous, others are not. The SRPA is located at about 137 m (450 ft) below ground surface (bgs) at the INTEC site.

2.1.2 Hydrologic Setting

Several sources of water contribute to moisture movement and the development of perched water in the INTEC subsurface. The two major recharge sources are the percolation ponds (bottom center, Figure 2-2) and the BLR (upper left, Figure 2-2). An average of 4.39 million liters (1.16 M gal) of wastewater is discharged to the percolation ponds each day. Depending on the snowpack and precipitation that occurs in a particular year, the BLR may flow all year or cease to flow entirely for several months or years. The mean annual flow in the BLR at a point near the INTEC site is 42,467,544 m^3/month (34,429 acre-ft/month). Together, these two sources are thought to supply about 90% of the recharge. The wastewater treatment lagoons (upper right, Figure 2-3), operational activities, and precipitation account for the remaining recharge. Average annual discharge to the wastewater treatment lagoons is 52,617 m^3/yr (13.9 M gal/yr). Operational losses are variable and not well quantified. The mean annual precipitation at the INEEL is approximately 21.5 cm/yr (8.5 in./yr). Usually, less than half of this occurs as snowfall. The collection of precipitation in local basins can supply substantial amounts of focused infiltration.

As the wetting front moves downward through the surficial sediments, it may move through contaminated sediments where the contaminants may be mobilized and transported. The water continues its downward movement until it encounters an underlying fractured basalt flow where it is likely to collect and move laterally along the sediment/basalt interface until it encounters preferential pathways which may be associated with a fracture network or permeable rubble zones between basalt flows. In the basalt the majority of water is believed to flow as a saturated front through high permeability systems consisting of fractures and permeable interflow zones. This results in rapid water movement through the entire fractured basalt portion of the subsurface.

If the infiltrating water encounters sedimentary interbeds, the water may spread laterally moving down gradient. A permeability contrast between the interbed, the fractures, and basalt matrix causes the water to pond and spread. One result of this contrast is the development of perched water in association with the interbeds. The perching may occur either on the interbeds or dense basalt. However, most of the perched water at INTEC appears to be associated with the interbeds.

The extent to which water moves horizontally while vertically transiting the fractured basalts is uncertain. Water has been shown to move laterally several miles in the subsurface when sufficient water was available to support long lateral spread. Eventually, water infiltrating at the surface of the INTEC will reach the underlying SRPA.

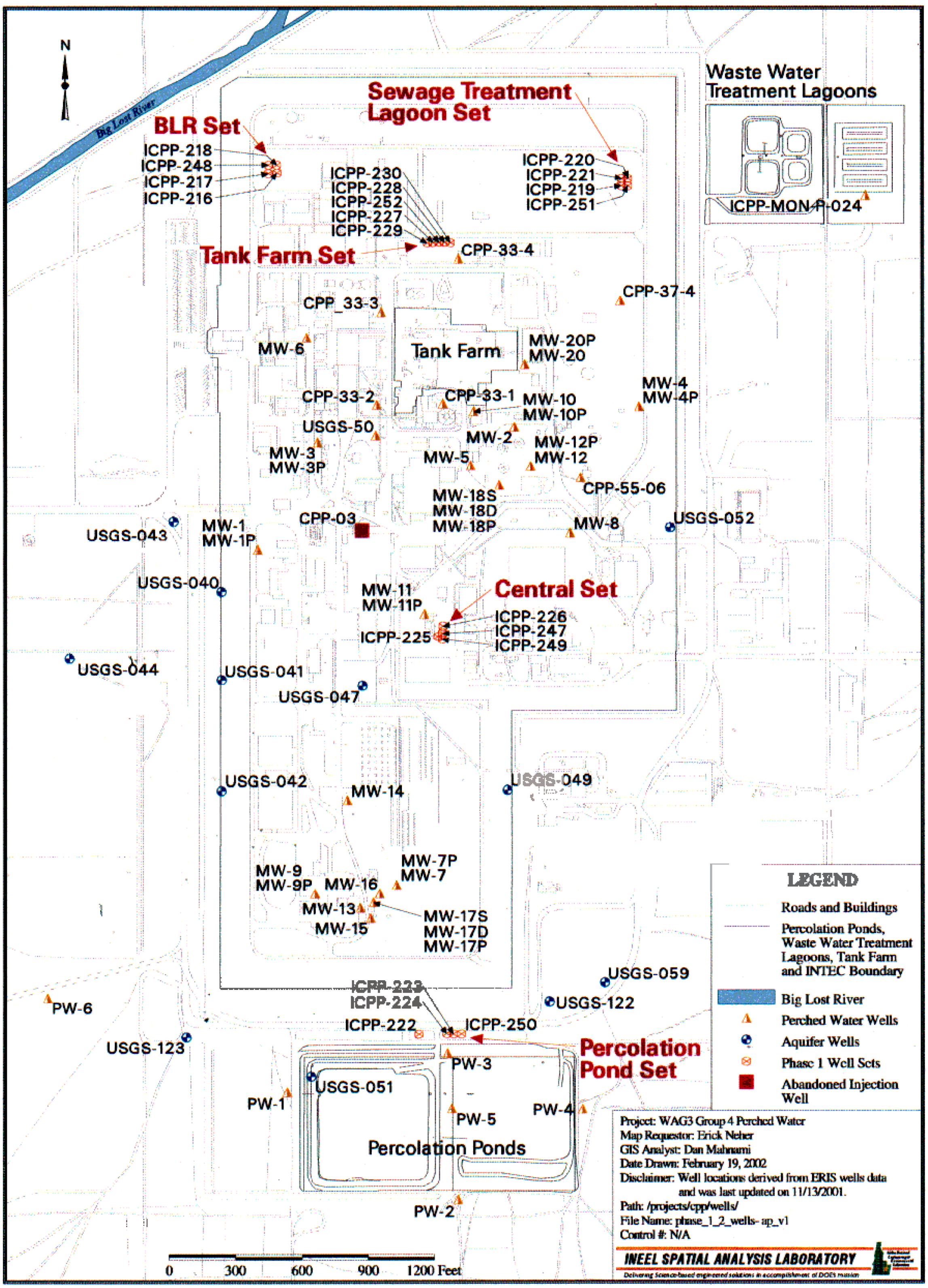

Figure 2-2. Map of INTEC showing Phase I well locations.

2.2 Perched Water

Perched water bodies are significant because they increase the opportunity for contaminants to move both laterally and vertically in the vadose zone. This lateral water and contaminant movement in the vadose zone results in vertical migration rates that are spatially nonuniform beneath the INTEC. Infiltration from the surface is assumed to move vertically through the basalt to an interbed. The water and contaminants migrate along the interbed and accumulate at interbed low points because the interbeds are sloped. This results in greater than average vertical water and contaminant fluxes in water accumulation areas and less than average vertical water and contaminant fluxes in the elevated portions of the interbed. Perched water bodies increase the complexity of flow and transport through the vadose zone.

Several zones of perched water have developed in the vadose zone as a result of site operations and natural recharge sources. The perched water bodies have been found in three zones in the subsurface:

- The interface between the surface alluvium and the shallowest basalt flow.
- An upper zone associated with the CD and DE3 interbeds at depths between 34 and 53 m. 113 ft and 170 ft) bgs. This shallow zone is further subdivided into an upper shallow zone and a lower shallow zone.
- A lower zone associated with the DE6 and DE8 interbeds at a depth of about 97 to 128 m (320 to 420 ft) bgs.

Figure 2-3 shows a geologic cross-section running from north to south through the INTEC. The names of the basalt flows and interbeds are shown in the figure. Also depicted are locations where perched water is thought to exist. The perched water has varying degrees of radionuclide concentrations, with the northern upper perched zone showing the highest concentration levels.

2.2.1 Perched Water in Surficial Alluvium

In places with a concentrated source of surface recharge, a perched water zone can develop in the surficial alluvium on top of the first basalt flow. Perched water has been identified in the alluvium at the INTEC beneath surface disposal ponds (the percolation ponds and the sewage treatment pond). A small perched water table in alluvium was encountered west of CPP-603. The source for the perched water was assumed to be wastewater that was discharged to a shallow seepage pit (Robertson et al. 1974).

Perched water in the surficial alluvium requires a concentrated source of recharge that exceeds the normal recharge provided by precipitation. Perched water has not been widely measured at the sediment-basalt interface.

2.2.2 Upper Perched Water Zone

As shown in Figure 2-3, the upper portion of the shallow upper perched water body is present above the CD and D interbeds, and the lower portion of the upper perched water body has been identified on the DE3 interbed. The CD interbed occurs at depths between 34 and 36 m (113 and 119 ft) bgs, the D interbed occurs at depths between 39 and 41 m (128 and 135 ft) bgs, and the DE3 interbed occurs at depths between 50 and 52 m (163 and 170 ft) bgs.

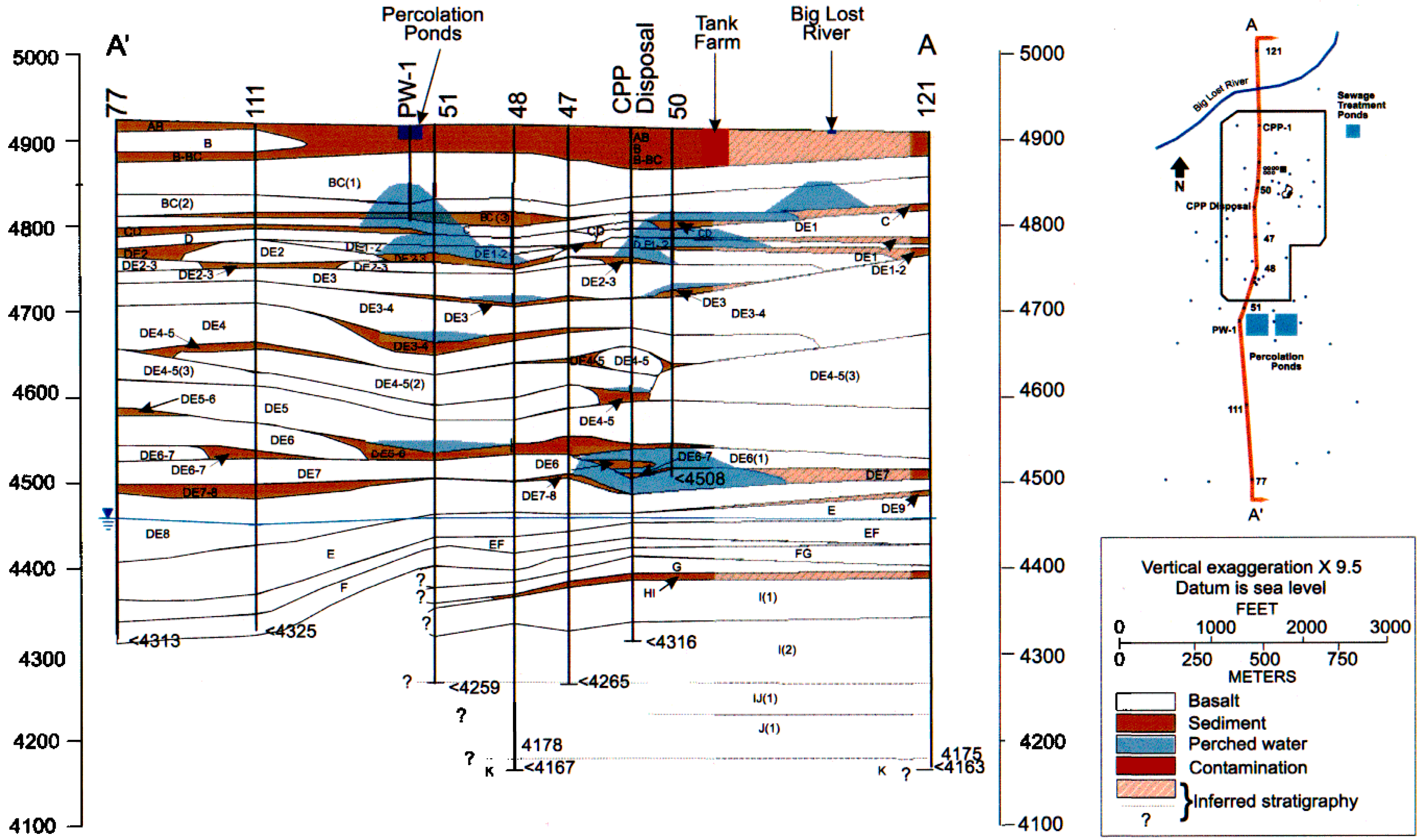

Figure 2-3. Cross-section of the vadose zone at the INTEC.

The upper perched water zone is frequently divided into the northern and southern zones because it appears to be two discrete water bodies. Figure 2-4, taken from the ROD, shows an interpretation of the approximate extent of the upper perched water zones. The actual extent of the perched water bodies could be quite different because the perched water boundaries are not well defined. Even within the upper zones, the zones appear to occur as fragmented rather than continuous perched water bodies. The connections between the perched water bodies are not well understood.

Based on the upper perched water configuration, it appears that multiple water sources are providing recharge to the upper perched water body in the northern portion of the INTEC. These sources may include recharge from the BLR, the wastewater treatment lagoons, and operational releases. The wastewater treatment lagoons, located northeast of the facility, provide approximately 4.73×10^6 L (1.25×10^6 gal) per month of recharge to the eastern side of this perched water body. This recharge has resulted in a water table elevation of approximately 1,477 m (4,845 ft) above median sea level (amsl) in the well (CPP-MON-P-024) (see Figure 2-2, upper right) completed near the sewage treatment ponds. In the western portion of the perched water body and beneath the main portion of the facility, recharge from an unknown source has produced a water table elevation of 1,467.7 m (4,815.2 ft) amsl in Well CPP-33-2. Between the eastern and western portions of the upper perched water body, the groundwater elevation is 1,465.7 m (4,808.8 ft) amsl in Well CPP-37-4. Fluctuations in water levels in the upper perched water zone that are observed in response to flow in the river indicate a connection between the northern upper perched water and the river.

Perched water has been identified beneath two areas of the southern INTEC. A small, perched-water body has been identified in the vicinity of building CPP-603 and a larger perched water body has developed from the discharge of wastewater to the percolation ponds. The southern upper perched zone is thought to be primarily recharged by the percolation ponds. The water elevations in the southern perched water zone range between 1,442.4 to 1,460.0 m (4,732.4 to 4,790.2 ft) amsl north of the percolation ponds near Building CPP-603, and between 1,461.9 to 1,477.9 m (4,796.2 to 4,848.9 ft) amsl near the percolation ponds. Only two upper perched water wells (see Figure 2-2) are located between the northern and southern perched water bodies (MW-11 and MW-14), and neither indicates perched water in these areas.

2.2.2.1 Northern Perched Water Contamination. The highest perched water radioactive contamination occurs beneath the northern portion of the INTEC, particularly associated with MW-2, MW-5, and CPP 55-06 (see Figure 2-2). The maximum gross alpha and gross beta activities measured in the upper perched groundwater were 1,140 ±220 pCi/L and 589,000 ±2,600 pCi/L respectively, in well MW-2. At a depth of approximately 42 m (140 ft), the maximum gross alpha and gross beta concentrations measured in the perched water were 137 ±9 pCi/L and 65,300 ±600 pCi/L in wells MW-10 and MW-20.

The most significant radionuclides in the upper perched water body are Sr-90 and Tc-99. Low levels of H-3 were also detected in the upper perched water zone. The low H-3 concentrations in the upper perched water zone is a significant contrast to the waste stream that was directed to the INTEC disposal well where the vast majority of the associated radioactivity consisted of H-3. Strontium-90 was detected in all wells completed in the northern area of the upper perched water zone. The maximum Sr-90 concentration detected was 320,000 ±3,000 pCi/L (well MW-2) followed by 104,000 ±1,000 pCi/L (well MW-5) and 66,300 ±600 pCi/L (well CPP 55-06). The only other fission product detected in the upper perched groundwater is Tc-99. Tc-99 has been detected in all wells except CPP 33-4 and MW-6. The maximum Tc-99 concentration detected in the upper perched groundwater zone was 38000 ±500 pCi/L in well MW-10.

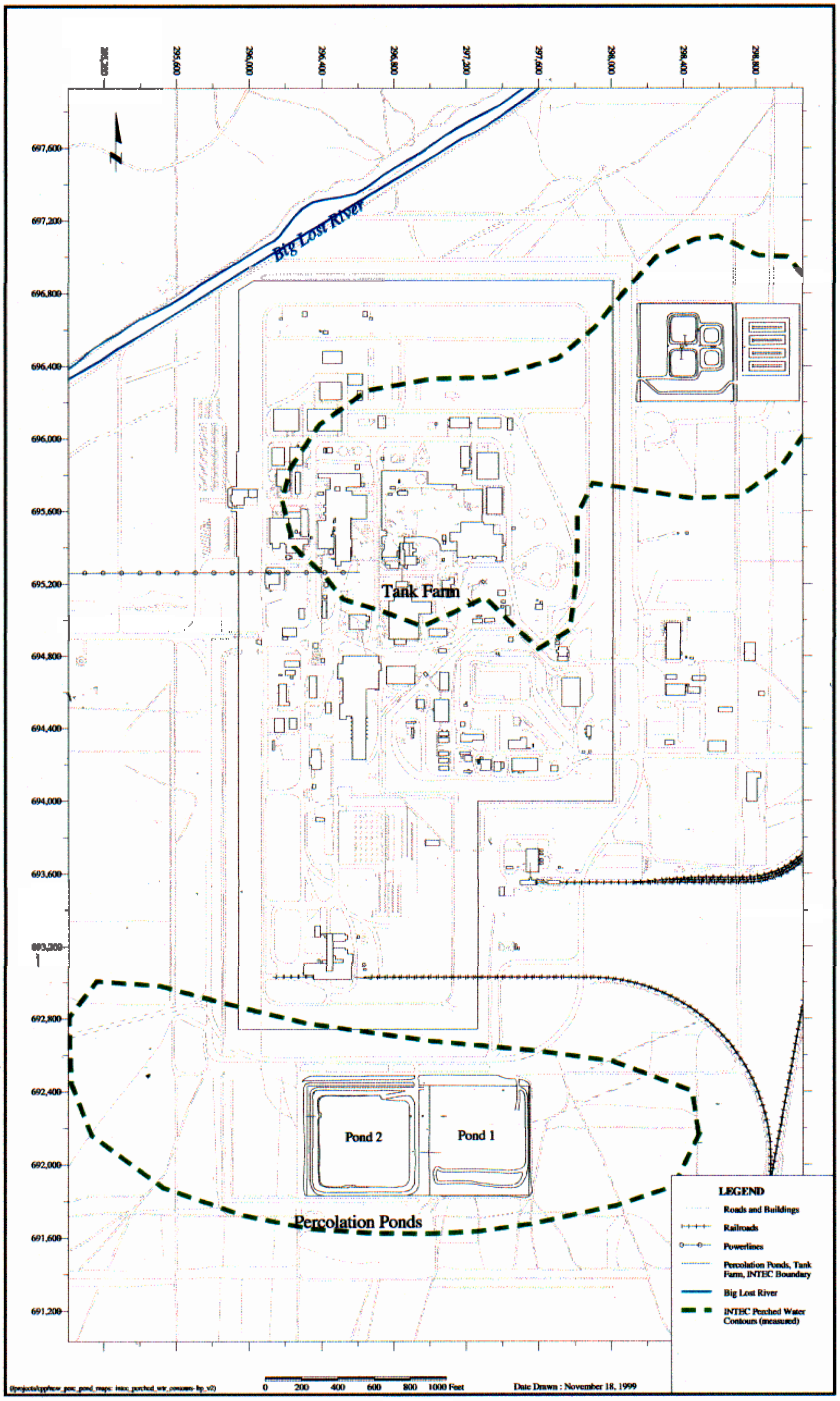

Figure 2-4. Approximate extent of the shallow perched water at INTEC.

Two wells (MW-10 and MW-20) are completed in water-bearing zones at depths of approximately 42 m (140 ft). The maximum concentrations for H-3, Sr-90, and Tc-99 from these wells are 38,000 ±50 pCi/L, 25,800 ±30 pCi/L, and 127 ±2 pCi/L respectively. A comparison of the water quality from the wells completed in the upper perched groundwater body (at approximately 33 m [110 ft]) to this deeper zone indicates an increase in both H-3 and Tc-99 concentrations and a decrease in the Sr-90 concentrations.

2.2.2.2 Southern Perched Water Contamination. Wells that monitor the perched water quality in the upper southern perched water zone around CPP-603 include MW-7, MW-9, MW-13, MW-14, MW-15, MW-16, and MW-17. From the inorganic analysis, only nitrate/nitrite was detected at a concentration exceeding the maximum concatenation level (MCL) at well MW-15 (14.7 mg/L). The radionuclides detected in the perched water include H-3 (3,360 ±176 to 25,700 ±400 pCi/L) and Tc-99 (6.4 ±0.6 to 23.7 ±0.6 pCi/L). In addition, Sr-90 and U-234 were detected in MW-15 at concentrations of 17,200 ±200 pCi/L and 11.8 ±1 pCi/L, respectively.

Perched water in the percolation pond area is monitored by six wells, designated as PW-1 through PW-6, which monitor the upper-most perched water body associated with wastewater discharge to the percolation ponds. These wells have been monitored by the United States Geological Survey (USGS) since 1987. Wells PW-1, PW-2, PW-4, and PW-5 have been sampled on a quarterly basis as part of the INTEC groundwater-monitoring program since 1991 (INEEL 1995).

Most of the historical radioactivity present in the PW-series wells is from H-3, with Sr-90 providing a secondary activity contribution. According to the USGS monitoring, activities from both H-3 and Sr-90 have remained relatively stable with the exception of an increased H-3 activity period in mid-1988. Average H-3 concentrations range from 1,334 ±421 to 4,681 ±567 pCi/L with Sr-90 concentrations averaging 3.7 ±3.4 pCi/L.

2.2.3 Lower Perched Water Zone

A deep perched water zone has been identified in the basalt between 98 and 128 m (320 and 420 ft) bgs. This one was first discovered in 1956 when perched groundwater was encountered at a depth of 106 m (348 ft) while drilling well USGS-40 (Robertson et al. 1974). Since then, perched water has been encountered in this zone during the drilling of wells USGS-41, USGS-43, USGS-44, USGS-50, USGS-52, MW-1, MW-17, and MW-18. Borehole neutron logs run from Wells USGS-40, USGS-43, USGS-46, USGS-51, and USGS-52 indicate that in 1993 perched water may still have been present in this zone.

Only four wells are completed in the deep perched water zone. Wells MW-1, MW-18, and USGS-50 are completed in the northern portion of the facility, and water has been encountered at approximately 85, 107.5, and 101 m (322, 407, and 383 ft) bgs, respectively. In the southern portion of the INTEC facility, only Well MW-17D is completed in the lower perched water zone in which water is encountered at a depth of approximately 96 m (364 ft) bgs (see Figure 2-2).

Similar to the upper perched water zone, it is thought that the lower perched water zone is formed by decreased permeability associated with sedimentary interbed layers. It appears that the lower perched water has formed primarily on the DE7 interbed (see Figure 2-3). The top of this interbed occurs beneath the INTEC at depths ranging from 101 to 112.5 m (383 to 426 ft) bgs in the western portion of the INTEC facility. However, the DE6 interbed is responsible for creating perched water associated with Wells USGS-40 and USGS-43. The lower perched water zone is not continuous beneath the entire facility and may actually consist of several individual perched water bodies. Recharge to the southern perched water body is from service wastewater discharged to the percolation ponds. The source of recharge to the western portion of the northern perched water body is unknown, though the BLR and facility water leaks are likely contributors.

Water levels in the lower perched water zone have been monitored since the early 1960s in well USGS-50. The water level in this well has been fairly consistent, ranging between 1,381 and 1,384 m (4,530 and 4,540 ft) amsl. In the late 1960s and 1970s, however, the water level increased by approximately 27.4 m (90 ft) in response to failure of the INTEC injection well, Site CPP-23. During this period, wastewater was discharged directly to the vadose zone from the INTEC injection well at a reported depth of 69 m (226 ft) bgs (Fromm et al. 1994). Measurements made in 1966 showed that the well was intact. Therefore, most of the collapse took place in 1967 or early 1968. The period when the INTEC injection well was plugged and discharged directly into the vadose zone has resulted in a thick zone of contamination underlying INTEC. This zone serves as a possible source of contamination to the deep perched water zone and complicates any interpretation of contamination in the subsurface.

In September 1970, a drilling contractor began to redrill and reline the injection well to its original depth. By October, deepening had progressed to about 152.4 m (500 ft) and the water level in the well had resumed its normal depth at about 138.7 m (455 ft). During the well repair, wastewater was disposed of to USGS-50. The injection well collapsed again and had to be reopened to the water table in late 1982. At this time, a high-density polyethylene liner 25.4 cm (10 in.) in diameter was placed in the well from ground level to the bottom of the well. The liner was perforated from 137 m (450 ft) bgs (approximately 2.4 m [8 ft] above the water table) to the bottom of the well. On February 7, 1984, the injection well was taken out of routine service, and wastewater is now pumped to percolation ponds 1 and 2.

2.2.3.1 Lower Perched Water Contamination. Contamination in the lower portion of the vadose zone is different in composition from the upper perched zone. The lower vadose zone perched water contamination results from the two INTEC injection well (Site CPP-23) collapses where service wastewater was released into the vadose zone above the lower sediment and the migration of upper perched water toward the SRPA. Lower perched water is monitored at the INTEC by wells MW-1, MW-17, MW-18, and USGS-50 that are completed in water-bearing zones occurring at depths between 99.4 to 102.4 m (326 to 336 ft), 109.7 to 116.1 m (360 to 381 ft), 120.1 to 126.2 m (394 to 414 ft), and 109.7 to 123.4 m (360 to 405 ft) respectively. Historically, two rounds of perched water samples have been collected from MW-1, one round of perched water samples has been collected from MW-17 and MW-18, and a substantial database concerning radioactive contaminants is available for the water quality from USGS-50. Results from these water-sampling events are described in the WAG 3 RI/FS Work Plan (INEEL 1995).

Well MW-1 is located in the northern INTEC. Nitrate/nitrite was detected at a concentration of 69.6 mg/L. The radionuclides detected in water samples from well MW-1 include Sr-90 (4.5±0.4 pCi/L) and H-3 (24,700±400 pCi/L). Of these contaminants, only H-3 was measured above the federal primary MCL of 20,000 pCi/L. Since H-3 concentrations in the deep perched water zone are higher than the H-3 concentrations in the overlying perched water bodies, the source of this contamination is either a historical release where the contaminants have moved through the system, or wastewater disposal to the ICPP injection well.

Well MW-18 is completed in the deeper perched water zone near the eastern boundary of the INTEC. From the June 1995 sampling event, only nitrate/nitrite concentration at 34.4 mg/L exceeded either a federal primary or secondary MCL. The radionuclides detected in the deep perched groundwater at this location include H-3 (73,000±700 pCi/L), Sr-90 (207±2 pCi/L), and Tc-99 (736±6J pCi/L). The H-3 and Tc-99 concentrations from this well are some of the highest concentrations measured in the perched water beneath the ICPP.

USGS-50 was originally intended to be completed in the SRPA, but was ultimately drilled to a total depth of 123 m (405 ft) to monitor a lower perched water zone. This well is located in the north central portion of the facility. The highest concentrations of H-3 and Sr-90 occurred in 1969 and 1970. These elevated concentrations were attributed to the failure of the ICPP disposal well where the wastewater was injected into the vadose zone rather than directly to the aquifer.

From the May 1995 water sampling of USGS-50, the concentrations of all chemical contaminants except nitrate/nitrite were below federal primary or secondary MCLs. Nitrate/nitrite concentration was measured at 31.3 mg/L, compared to the federal primary MCL of 10 mg/L. Radionuclides in the perched water that were detected include H-3 (61,900±700 pCi/L), Sr-90 (151±2 pCi/L), and Tc-99 (63±1J pCi/L). The concentrations for H-3 and Sr-90 are within the expected values based on the historical sampling conducted by the USGS.

Well MW-17 is the only deep perched water monitoring well located in the southern portion of the INTEC. This well has been constructed to monitor three perched water bodies: an upper zone from 55.4 to 58.4 m (181.7 to 191.7 ft) bgs, a middle zone from 80.4 to 83.5 m (263.8 to 273.8 ft) bgs, and a lower zone from 110 to 116 m (360 to 381 ft) bgs. During the May 1995 sampling event, water was only present in the upper and lower zones. None of the chemical constituents detected in the perched water exceeded either a federal primary or secondary MCL. Only two radionuclides (H-3 and Tc-99) were detected in perched water samples collected from MW-17. The concentrations of these two radionuclides were similar between the upper and lower perched water zones. H-3 concentrations varied from 25,100 ±400 to 25,700 ±400 pCi/L, and Tc-99 concentrations varied from 5.9 ±0.6 to 6.4 ±0.6 pCi/L.

2.3 Contaminants of Concern

COCs identified in the OU 3-13 WAG 3 baseline risk assessment are primarily radionuclides. The upper perched zone COCs are strontium-90 and tritium (H-3). COCs in the deep perched zone includes the above contaminants as well as americium-241, neptunium-237, technicium-99, cesium-137, iodine-129, plutonium isotopes, uranium isotopes, and mercury. The difference in composition of contaminants in the upper and lower perched water zones is a result of their different contaminant sources. Contamination in the upper perched water results from contaminants being leached from surface sources while the lower perched water resulted from combination of injection well failures and downward contaminant migration. By Agency request, hazardous substances to be included with the Phase I COC analyses include carbon tetrachloride, 1,1,1-trichloroethane (TCA), trichloroethylene (TCE), tetrachloroethylene (PCE), benzene, toluene, and carbon disulfide. The volatile organic compound (VOC) sampling will be discontinued in Phase II if they are not detected at concentrations above MCLs in the initial sampling. Geochemical sampling will include cations and anions.

3. FIELD SAMPLING PLAN OBJECTIVES

NOTE: *The DQO discussions below for Phase I were written in September 2000 (prior to Phase I well installations) and are retained in the original form. For details on the final methodology and status of Phase I activities, refer to the Phase I Monitoring Well and Tracer Study Report (DOE-ID 2002).*

The objective of this FSP is to clearly define the drilling, core collection, installation of instrumentation at both new (Phase I and Phase II) and existing vadose zone wells and to collect and analyze groundwater samples from these new and existing wells. A separate monitoring plan (DOE-ID 2000a) has been prepared to detail the routine collection, analysis, and evaluation of data from the newly installed instruments and groundwater samples.

3.1 Data Quality Objectives

The EPA developed the DQO process as a means to "improve the effectiveness, efficiency, and defensibility of decisions" used in the development of data collection designs (EPA 1994). The DQO process is a systematic procedure for defining data collection criteria based on the scientific method. This process consists of seven iterative steps that yield a set of principal study questions and decision statements that must be answered to address a primary problem statement. The seven steps comprising the DQO process are listed below:

- Step 1: State the problem
- Step 2: Identify the decision
- Step 3: Identify the inputs to the decision
- Step 4: Define the study boundaries
- Step 5: Develop decision rules (DRs)
- Step 6: Specify limits on the decision
- Step 7: Optimize the design for obtaining data.

The following sections present details on each of the DQO steps to be answered by the work conducted under this FSP. The DQOs as discussed in the following sections have been negotiated and approved by the supervising agencies. Table 3-1 presents a summary of the DQO process for the Group 4 remediation goals.

3.1.1 State the Problem

The WAG 3 ROD requires that it be determined, through site monitoring activities, if relocation of the percolation ponds has been successful in meeting the OU 3-13 Group 4 remediation goals. The ROD establishes two remediation goals for the perched water of (1) "reduce recharge to the perched water," and (2) "minimize migration of contaminants to the SRPA, so that SRPA groundwater outside of the current INTEC security fence meets the applicable State of Idaho groundwater standards by the year 2095" (DOE-ID 1999, Sect 8.1.4, p 8-9). If these goals are not met, then additional infiltration controls are required (Phase III). Per the ROD, the next contingent remedial action will be lining the BLR, if

Table 3-1. WAG-3, OU 3-13, Group 4, Perched Water DQO table.

1: State the Problem	2: Identify the Decision			3: Identify Inputs to the Decision	4: Define the Study Boundaries
Is relocating the percolation ponds successful in meeting the OU 3-13 Group 4 remediation goals (i.e., preventing migration of radionuclides from perched water in concentrations that would cause the SRPA groundwater to exceed drinking water standards in 2095), or are additional infiltration controls necessary. Per the ROD, the next contingent remedial action will be lining the BLR, if relocation of the percolation ponds is not successful in meeting the remediation goal.	Success at meeting the RAO will be based upon a determination of whether we have met the Group 4 remediation goals (DOE-ID 1999, Sec 8.1.4, p 8-9).				This study focuses on the transport of COCs from the vadose zone to the SRPA. Specifically excluded from this study is contamination of the surface soils (alluvium to top of basalt) at INTEC which are covered under other programs. The physical boundaries of the study area are from the BLR (on the north) to the percolation ponds at the south end of INTEC. The east-west boundaries roughly correspond to the east-west perched water zones and include the sewage treatment lagoons and probably a portion of the BLR. At depth, the boundaries of the study area are from the top of basalt down and into the top of the SRPA. To aid in the remedial action evaluation and based on the physical characteristics of the perched water bodies and locations of recharge sources, the vadose zone will be divided into a northern-upper, northern-lower, southern-upper, and southern lower perched water zones. The boundary between north and south will be marked by an east-west line across the southern end of the FAST building (CPP-666). The boundary between the upper and lower perched water is placed at a depth of 200 feet between what is commonly referred to as the upper interbeds (110-140 ft) and lower interbeds (~380 ft). The division of the vadose zone into four discrete study areas allows for independent review of each of these areas as the remedial action progresses. The tracer test data will be used to determine the connectivity between the perched water zones for compliance monitoring. The Group 4 remedial activities will be undertaken in three phases. The purpose of the first phase is to obtain information and background data while the percolation ponds are working to establish compliance monitoring and will include installation of 15 wells, conducting a series of tracer tests, and monitoring moisture content and COC concentrations. The purpose of Phase II is to monitor the drain out of the perched water following relocation of the percolation ponds and will include drilling additional wells. Phase III includes the BLR contingency (if required) and long-term monitoring. Lining of the BLR will require fulfilling additional requirements such as NEPA and a factual determination per CFR Title 40, Part 230, "Section 404(B)(1), Guidelines for Specification of Disposal Sites For Dredged or Fill Material," modification to the Statement of Work, and possibly, additional field investigations to support an explanation of significant differences or ROD amendment.
	Principal Study Questions	Alternative Actions	Decision Statement		
	PSQ-1a: Has the moisture content in the vadose zone beneath INTEC been reduced to moisture levels predicted by the WAG-3 OU 3-13 vadose zone model (DOE-ID 10572) within 5 years following the percolation pond relocation? Note 1: Data to resolve this question will be collected before and after the removal of the percolation ponds. Note 2: Data to answer PSQ-1a will initially be compared with data from the existing OU 3-13 vadose zone model. The collected data will be used to revise the model. After the model is revised, it will be used to predict future conditions.	AA-1a: Alternatives to PSQ-1a include (1) determining whether the measured moisture content is less than or equal to levels predicted by the WAG 3 OU 3-13 model or (2) determining whether the measured moisture content remains greater than that predicted by the model.	DS-1a: Determine whether relocation of the percolation ponds has been sufficient to reduce moisture contents in the vadose zone to levels less than or equal to those predicted by the WAG-3 OU 3-13 vadose zone model.	The inputs to PSQ-1a are 1) Spatially distributed matric potential measurements from new tensiometers installed within each of subsurface zones at INTEC 2) WAG-3 OU 3-13 vadose zone numerical model derived matric potential action levels for each of the same subsurface zones 3) Moisture characteristic curves for the interbed sediments 4) Tracer test data a) Tracers will be unique fluorescence dyes, which are not currently being used at the INEEL b) Tracer tests will be performed to evaluate hydraulic continuity, recharge sources, and travel times.	
	PSQ-1b: Has the COC[a] flux to the SRPA been reduced during the initial 5 years of monitoring following the percolation pond relocation such that water quality in the SRPA meet applicable standards by 2095? Note: If there are changes to COC Kds per OU 3-14 or INTEC evaluation, these will be incorporated by consensus as appropriate.	AA-1b: The alternative to PSQ-1b is that the COC flux to the SRPA will result in groundwater concentrations in the SRPA exceeding MCLs or remedial action objectives (RAOs)/Regulatory Guides (RGs) in 2095 and beyond.	DS-1b: Determine whether relocation of the percolation ponds has reduced the flux of COCs to the SRPA such that the predicted COC concentrations in the SRPA will not exceed MCLs or RAOs/RGs in 2095 and beyond.	The inputs to PSQ-1b are 1) Collection and chemical analysis for COCs of perched water samples from existing vadose zone monitoring wells 2) Collection and chemical analysis for COCs of soil water samples from new and existing lysimeters 3) Measurement of water levels in existing vadose zone monitoring wells 4) Measurements of (soil moisture) tension from new tensiometers 5) Collection and analysis of interbed sediment samples at locations of new tensiometers for development of moisture characteristic curves and grain size analysis 6) Collection and chemical analysis for COCs of groundwater samples from new and existing monitoring wells installed in the SRPA 7) Collection of and chemical analysis of tracers in perched water 8) Measurement of water levels in new and existing monitoring wells installed in the SRPA 9) Recharge water source information for precipitation, BLR flows, and facility discharge volumes 10) Incorporation of monitoring data, collected during the 5 years following relocation of the percolation pond, into the refined WAG-3 OU 3-13 model and calculation of the predicted concentrations of COC in the SRPA in year 2095 and beyond.	
	PSQ-2: Based upon monitoring of the percolation pond relocation (PSQ-1a and PSQ-1b), are additional recharge controls necessary?	AA-2: Alternatives to PSQ-2 will be based upon the answers obtained to PSQ-1a and PSQ-1b and include determining whether implementation of additional recharge control is required.	DS-2: Based upon the results of PSQ-1a and PSQ-1b, determine whether additional recharge control is required. If the answers to both PSQ-1a and PSQ-1b are yes, then the remediation goals have been met and additional recharge control is not required. If the answer to either PSQ-1b or PSQ-1b is no, then the remediation goals have not been met and further action is required.	The inputs to PSQ-2 are PSQ-1a and PSQ-1b will be inputs to PSQ-2. Both PSQ-1a and PSQ-1b will have either a "yes" or "no" answer. No additional field data is required for PSQ-2.	
	PSQ-3: Based upon new data obtained during evaluation of the percolation pond relocation and an evaluation of recharge sources, is lining of the BLR the recommended alternative if additional recharge controls are necessary?	AA-3: Alternative actions for PSQ-3 include determining whether lining the BLR is the preferred alternative for meeting the perched water RAO or determining whether recharge control or combination of controls are recommended.	DS-3: Determine whether additional recharge controls are required for meeting the RAOs and which additional recharge controls will be needed.	The inputs to PSQ-3 may include 1) Time-series water level and tension measurements in existing monitoring wells and in the Phase I and II wells. 2) Time-series data obtained from National Oceanic and Atmospheric Administration, USGS, and INTEC operations for information impacting recharge including BLR flow data; precipitation, temperature, pressure records; and percolation pond, sewage treatment lagoon, and other operational (if required) discharge volumes. 3) Perched water sample collection and analysis for tracers. 4) Perched water sample collection and analysis for basic geochemistry, e.g., anions and cations; isotopes, e.g. N14/N15 ratios; and source or recharge indicator chemicals, e.g., nitrates, caffeine, chloride. 5) Collection and analysis of source term waters for the same suite of analytes as perched water samples. Note: A final decision on exactly what the PSQ-3 inputs will be determined with Agency input following PSQ-2.	

Table 3-1. (continued.)

DOE-ID 1997, *Comprehensive RI/FS for the Idaho Chemical Processing Plant OU 3-13 at the INEEL—Part B, FS Report (final).*		
5: Develop a Decision Rule	6: Specify Tolerable Limits on Decision Errors	7: Optimize the Design
DR-1a: If, five years following the percolation pond relocation, the mean soil moisture content in the vadose zone sections, (e.g., north-upper, north-lower, south-upper, and south-lower), is equal to or less than the mean tension in soil moisture predicted by the refined WAG-3 OU 3-13 vadose zone model, then we can conclude that we have met the first remediation goal for Group 4.	The average soil tension measurement in each of the zones will be compared to the established action level for each zone. COC flux concentrations will be compared to MCL or RG values and established action levels. When data can be statistically manipulated, hypothesis testing will be utilized to determine if the action level is exceeded in any of the zones. The recommended null hypothesis, H_0, is that the true mean in each zone is greater than the action level. The alternative hypothesis is that the mean is less than or equal to the action level: H_0: $\mu >$ Action Level H_a: $\mu \le$ Action Level The hypothesis testing will be based upon small sample statistics (n < 30) and utilize the t test statistic: Test Statistic: $t = \dfrac{\bar{x} - hypothesized\ value}{s/\sqrt{n}}$ Using this test statistic and hypothesis, we would reject the null hypothesis (and thereby accept the alternative hypothesis) if the test statistic *t* is less than the negative value of the *t* critical value obtained from standard math tables given our number of samples and desired level of significance. In the case where decisions will be made by comparing data to computer predictions, the accuracy of the computer predictions will be the accuracy of the OU 3-13 model.	The design for the WAG-3 OU 3-13 Group 4 investigation will be implemented in phases. Phase I includes installation of five well sets to be drilled prior to conducting the tracer test. Vadose zone well sets will be located south of the BLR on the northwest corner of the tank farm, in a central location within the INTEC facility, west of the sewage disposal lagoons, and north of the existing percolation ponds. Phase I well sets will include a combination of: alluvial wells with instrumentation installed at about 45 ft bgs, upper perched water wells with instrumentation installed at about 120 to 140 ft bgs, lower perched water wells with instrumentation installed at about 380 to 420 ft, and possibly an aquifer well at about 460 ft. The justification for each Phase I well set follows. **Big Lost River Well Set.** This well set is located south of BLR. The alluvial well will provide a location for sampling any perched water that develops in the alluvium as result of flow in the BLR. The upper and lower perched water wells will provide locations for sampling the perched water zones in the northern INTEC area. The set is placed in a location near the BLR where monitoring wells currently do not exist. These wells will serve as the monitoring points for the BLR tracer (and other tracers should they be present). Wells at this location will help define the northern boundary and vertical extent of the perched water zones and will help identify the hydraulic connection between the river an the perched water zones. **Sewage Treatment Lagoon Well Set.** This well set is located southwest of the sewage treatment lagoon. The well set will provide sampling locations in northern INTEC in the alluvium (should any perched water develop in the alluvium as result of flow in the BLR or discharge from the sewage treatment lagoon) and in the upper and lower perched water. The set is placed in a location near the sewage treatment lagoons where no monitoring wells in the perched water currently exist. This well set will serve as the alluvium/basalt interface, upper, and lower perched water-monitoring points for the tracers. The wells at this location will help define the vertical depth and the northeastern boundary of the perched water zones. The wells will also provide information on the hydraulic connection between the river, the sewage treatment lagoon, and the perched water zones. **Percolation Pond Well Set.** This well set will provide a location for sampling perched water that develops on the alluvium and in the upper and lower perched water as result of wastewater disposal in the percolation ponds. The wells will be placed north of the percolation ponds at a location where no monitoring wells in the alluvium currently exist. (However, upper perched water wells exist to the north and south, and one lower perched water well exists to the north.) This well set will serve as monitoring points for the tracer introduced into the percolation ponds (and others if they are present). The wells will help identify the locations and vertical depth of the perched water and provide information on the hydraulic connection between the percolation ponds and the perched water zones. **Tank Farm Well Set.** This well set will be located on the northwest corner of the tank farm (see Figure 4-1) and will include four wells: alluvium, upper perched water, lower perched water, and aquifer skimmer. The location for this well set was selected to provide a monitoring point between the BLR and the tank farm and to access contaminated water that might move to the northwest from the tank farm. These wells will help define effects of the BLR flow on the perched water at the alluvium/basalt interface, in both perched water zones, and in the SRPA. **Central Well Set.** This well set is located in a central location between the north and south perched water bodies (see Figure 4-1). The cluster will monitor the shallow perched water and deep perched water zones. As nearby perched water wells (MW-11, MW-11P) have been dry at recent measurement events, the tensiometer and lysimeter data collected from this location will provide valuable information. Instrumentation in Phase I wells will include piezometers, deep tensiometers (to measure soil tension), suction lysimeters (for collecting water samples), and possibly moisture sensors. The piezometer will be installed in the borehole at the primary perched water zone. The suction lysimeters will be installed in the primary perching zone and other "wet" zones. A suction lysimeter will be placed in the well at primary perched water zone to determine contaminate concentrations for flux calculations following perched water drain out. The data may be used to determine contamination or recharge sources. If the moisture sensors can be successfully installed, field scale moisture characteristic curves will be developed. In Phase I, a unique tracer will be added to each of the major recharge sources: existing percolation ponds, the BLR, (tracer probably cannot be added directly to the river, [it will all flow off down stream], so it will be added to the vadose zone under or beside the river) and the sewage treatment lagoons. Perched water will be sampled and analyzed for tracer concentrations and other analytes to augment the added tracers. Tracer data will then be used to determine extent on perched water, the impact and interconnectivity of each recharge source on perched water, and to refine the WAG-3 OU 3-13 model. Phase I will also include collecting soil tension data from the Phase I perched water wells, collecting water samples from newly installed instrumentation as well as existing perched water wells and analyzing data for COCs and water geochemistry. COC analytes may include tritium, technicium-99, iodine-129, strontium-90, plutonium and uranium isotopes, mercury, and other hazardous constituents in addition to the COCs listed in the ROD. The hazardous substances may include carbon tetrachloride, 1,1,1-TCA, TCE, PCE, benzene, toluene, carbon disulfide, pyridine, and hydrogen fluoride. Geochemical analytes may include cations, anions, and caffeine and N14/N15. Water level data will also be collected from existing INTEC perched water wells. Phase II will involve installing additional well sets which may include an alluvial well (~45 ft bgs), a shallow perched water well (~120 to 140 ft bgs), a deep perched water well (~380 ft bgs), and an aquifer skimmer well (~450 ft bgs). Phase II will also include monitoring instrumentation installed in Phase I and Phase II wells, monitoring water levels in existing perched water wells, and COC and geochemical sampling of soil- and perched-water in new and existing wells. COCs including any additional hazardous substances will be sampled for annually during Phase I and II until the decision on the need for further recharge control is made (sometime after the 5 years following the relocation of the percolation ponds). Thereafter, they will be sampled for in 5-yr increments. Geochemistry samples will be collected initially (after completion of Phase I wells) and in years 2, 4, and 6 (percolation ponds will be relocated in year 2). Sampling and monitoring the vadose zone wells will continue during the 5 years following percolation pond removal. It is estimated that a network of about 60 wells will be sampled annually for COC chemical analysis. Moisture data from the same well network will be collected daily during this part of the investigation. After the 5 years provided that the drain out is occurring as predicted, monitoring and sampling will continue in a reduced well network (~20 wells) at reduced frequency. Phase III will be initiated only if the remedial contingency is implemented. In that event Phase III will include the installation of additional wells, additional recharge controls, and long term monitoring.
DR-1b: If, following the 5 years of monitoring and incorporation of those data into the refined WAG-3 OU 3-13 model, we predict through modeling that concentrations of COCs in the SRPA will be equal to or less than applicable MCLs or RGs in the year 2095 and beyond, then we can conclude that we have met the second remediation goal for Group 4.		
DR-2: If we conclude that both remediation goals have been met based upon DR-1a and DR-1b above, then we can conclude that the perched water RAO has been met and additional recharge controls are not required. If we conclude that either of the remediation goals, DR-1a or DR-1b, has not been met, then the RAO has not been met and per the ROD (DOE-ID 1999, Section 8.1.4., p 8-10), the contingency for limiting recharge from the BLR must be implemented.		
DR-3: If new data collected during the 5 years of monitoring indicate that the BLR is not a significant source of recharge to the vadose zone, then a ROD modification will be done and other recharge source(s) addressed.		

a. COCs include those contaminants identified in the ROD and may be supplemented by those identified following the first round of contaminant sampling. COCs include tritium, technicium-99, iodine-129, strontium-90, plutonium isotopes, uranium isotopes, and mercury.

relocation of the percolation ponds is not successful in meeting the remediation goal. The activities described are those required to monitor the results of the percolation pond relocation and determine if the results meet the remediation goals or if other remedial actions are required.

The primary perched water recharge sources include the percolation ponds at the south end of INTEC and the BLR to the north. Based upon numerical groundwater modeling, the estimated distribution of potential recharge sources is 70% percolation ponds, 20.7% BLR, 6.6% precipitation infiltration, 1.5% sewage treatment ponds, and 0.8% other sources (DOE-ID 1999, Sec. 5.2, p 5-4). Perched water at INTEC has been identified as potentially two distinct areas, the northern perched water and southern perched water (DOE-ID 1999, Fig. 1-6, p. 1-8). Perched water is also differentiated between a shallow perched water zone (approximately 33.5 to 42.7 m [110 to 140 ft] depth) and a deep perched water zone (approximately 115.8 m [380 ft] depth).

3.1.2 Identify the Decisions

This step of the DQO process lays out the principle study questions (PSQs), alternative actions (AAs), and corresponding decision statements (DSs) that must be answered to effectively address the above stated problem. The primary decision is to determine if, through the relocation of the percolation ponds, the perched water remedial action objective (RAO) (DOE-ID 1999, Sec. 8.1.4, bullet 3, p 8-3) of preventing migration of radionuclides from perched water in concentrations that would cause the SRPA groundwater outside the current INTEC fence line to exceed drinking water standards in 2095 and beyond, has been met. If relocation of the percolation ponds is insufficient to meet this goal, then additional recharge controls as stated in Section 8.1.4 of the ROD will be necessary. Such actions are outside the scope of this FSP. Evaluation of the success of relocation of the percolation ponds will be based upon whether or not one can demonstrate that the Group 4 remediation goals (DOE-ID 1999, Sec 8.1.4, p. 8-9) have been met. To further assist in this evaluation the vadose zone modeling conducted as part of the OU 3-13 RI/FS will be utilized. This modeling effort predicted that if the current percolation ponds were relocated the existing perched water bodies would dry out, thus preventing further migration of COCs.

3.1.2.1 Principal Study Questions. The purpose of the PSQ is to identify key unknown conditions or unresolved issues that, when answered, provide a solution to the problem being investigated, as stated above. The PSQs for this project are as follows:

PSQ-1a: Has the moisture content in the vadose zone beneath INTEC been reduced to moisture levels predicted by the WAG-3 OU 3-13 vadose zone model (DOE-ID 1997) within 5 years following the percolation pond relocation?

PSQ-1b: Has the COC flux from the perched water to the SRPA been reduced, during the initial 5 years of monitoring, following the percolation pond relocation such that water quality in the SRPA will meet applicable standards by 2095?

COCs include those contaminants identified in the ROD and may be supplemented by those identified following the first round of contaminant sampling. COCs include tritium, technicium-99, iodine-129, strontium-90, plutonium isotopes (Pu-238, -239, -240, and -241), uranium isotopes (U-234, -235, -238), neptunium-137, americium-241, and mercury.

PSQ-2: Based upon monitoring of the percolation pond relocation (PSQ-1a and PSQ-1b), are additional recharge control necessary?

PSQ-3: Based upon new data obtained during evaluation of the percolation pond relocation and an evaluation of recharge sources, is lining of the BLR the recommended alternative if additional recharge controls are necessary?

3.1.2.2 Alternative Actions. AAs are those actions possible resulting from resolution of the above PSQs. The types of actions considered will depend on the answers to the PSQs.

AA-1a: Alternatives to PSQ-1a include (1) determining whether the measured moisture content is less than or equal to levels predicted by the WAG 3 OU 3-13 model or (2) whether the measured moisture content remains greater than that predicted by the model.

AA-1b: The alternative to PSQ-1b is that the COC flux from perched water to the SRPA will result in groundwater concentrations in the SRPA exceeding MCLs or RAOs/RGs in 2095 and beyond.

AA-2: Alternatives to PSQ-2 will be based upon the answers obtained to PSQ-1a and PSQ-1b and include determining whether the implementation of additional recharge control is required.

AA-3: Alternative actions for PSQ-3 include determining whether lining the BLR is the preferred alternative for meeting the perched water RAO or determining whether other recharge control or combination of controls are recommended.

3.1.2.3 Decision Statements. The DSs combine the PSQ and AA into a concise statement of action. The DS for each of the PSQs are stated below.

DS-1a: Determine whether relocation of the percolation ponds has been sufficient to reduce moisture contents in the vadose zone to levels less than or equal to those predicted by the WAG-3, OU 3-13 vadose zone model.

DS-1b: Determine whether relocation of the percolation ponds has reduced the flux of COCs from perched water to the SRPA such that the predicted COC concentrations in the SRPA will not exceed MCLs or RAOs/RGs in 2095 and beyond.

DS-2: Based upon the results of PSQ-1a and PSQ-1b, determine whether additional recharge control (which may include lining the BLR) is required. If the answers to both PSQ-1a and PSQ-1b are yes, then the remediation goals have been met and additional recharge control is not required. If the answer to either PSQ-1b or PSQ-1b is no, then the remediation goals have not been met and further action is required.

DS-3: Determine whether additional recharge controls required for meeting the RAOs or whether alternate recharge controls will be more effective.

It is important to realize that the installation of an updated monitoring system and collection of new types of data during the post-ROD monitoring might modify the site conceptual model for vadose zone flow and transport beneath WAG 3. If the conceptual model is significantly changed, DS 1 may need to be reevaluated in terms of the updated conceptual model.

3.1.3 Identify Inputs to the Decision

This step of the DQO process identifies the informational inputs that are required to answer the decision statements made above.

3.1.3.1 Inputs for PSQ-1a. PSQ-1a will be answered by a direct comparison of field measurements of vadose zone soil moisture to predicted soil moisture as calculated by the existing WAG 3 vadose zone model. Field measurement of soil matric potential from the sedimentary interbeds and basalts beneath INTEC will be performed. The installation of tensiometer, measurement of moisture pressure head can be made at both below atmospheric (unsaturated) and above atmospheric (saturated) pressures. Because the existing monitoring network consists of solely peizometers, only fully saturated conditions can currently be detected. It is anticipated that with relocation of the percolation pond, perched zones will drop below full saturation early on in the monitoring. Therefore, the existing vadose zone monitoring system is insufficient for this task.

The comparison of field data to model calculated predictions will be accomplished through the comparison of spatially averaged field data from four zones of the INTEC subsurface to calculated predictions from approximately the same volume within the numerical model domain. To facilitate this comparison the INTEC will be divided into four discrete zones based upon the north and south perched water areas, and the deep and shallow interbed depths. This will produce the following four areas: a north-shallow, north-deep, south-shallow, and south-deep zone.

Simply stated, the inputs to PSQ-1a are

1. Spatially distributed matric potential measurements from new tensiometers installed within each subsurface zone at INTEC.

2. WAG-3 OU 3-13 vadose zone numerical model derived matric potential action levels for each of the same subsurface zones.

3. Moisture characteristic curves for the interbed sediments.

4. Tracer test data to evaluate hydraulic continuity of perched zones, recharge sources, and travel times from those sources. Tracer tests will use unique fluorescence dyes, which are not currently being used at the INEEL.

3.1.3.2 Inputs for PSQ-1b. In order to estimate a contaminant flux following relocation of the percolation ponds and support numerical modeling, information is required regarding (a) time-series concentrations and aerial distribution of contaminants in the vadose zone beneath INTEC, (b) water flux through the area of contamination in the vadose zone beneath INTEC, (c) material properties of the subsurface sediments and contaminants affecting contaminant transport in the vadose zone, (d) time-series concentrations and distribution of contaminant in the SRPA beneath INTEC, (e) water flux through the SRPA beneath INTEC, and (f) material properties of the SRPA material and contaminants affecting the contaminant transport.

The field data to support (a), above, will come from sampling a combination of the existing vadose zone monitoring wells, and the installation and sampling of new suction lysimeters installed in conjunction with the new tensiometers called out in PSQ-1a. The existing wells provide significant information regarding the trends in COC concentrations throughout a wide area of the INTEC subsurface where saturated conditions presently exist. The addition of new lysimeters is considered necessary to monitor the system as areas dry out, and sampling with existing monitoring wells is no longer possible.

The field data to support point (b) will also come from utilization of existing and new equipment installations. While not the ideal monitoring system, the existing monitoring wells provide useful information regarding the distribution of saturated conditions in the vadose zone. In addition, new tensiometers will provide soil moisture tension data in the vadose zone as the system dries out and falls below saturation. In order to calculate the flux under both the saturated and unsaturated conditions, collection of sediment samples from the locations of each tensiometer will also be needed. This is required to establish the soil structure in which the tension measurement is made. Flux estimates require both a head or gradient measurement and a conductivity estimate. The tensiometers will provide the head measurements. Collection and analysis of sediment samples will allow for soil texture classifications of the interbed material, which can be used with empirical methods, to estimate both the hydraulic conductivity and moisture content.

Additional data is not considered necessary for the determination of material properties affecting retardation of contaminants in both the unsaturated and saturated zones, as referenced in inputs (c) and (f). This information is already incorporated into the existing WAG 3 vadose zone model.

The field data to support point (d), will be developed through sample collection from new and existing SRPA monitoring wells at INTEC. A series of USGS monitoring wells exists in the southern portion of INTEC that will allow for tracking contaminant trends in the SRPA. However, only limited SRPA well coverage is present beneath the areas of highest vadose zone contamination near the tank farm. Additional wells to allow determination of flux of COC concentrations at the top of the SRPA in the northern portion of INTEC are recommended to supplement monitoring of the COCs in the SRPA beneath INTEC.

The field data to support point (e), will be obtained through monitoring water levels in the SRPA in both new and existing monitoring wells beneath INTEC.

Finally, this data will be collected for a period of 5 years following the percolation pond relocation and trend information generated. Data and trend information will be incorporated into the WAG 3 vadose zone model to predict the slope of the drain out curve at five years and the value at five years.

Thus, the inputs to PSQ-1b are

1. Collection and chemical analysis for COCs in perched water samples from existing vadose zone monitoring wells.

2. Collection and chemical analysis for COCs of soil water samples from new lysimeters installed with new tensiometers.

3. Measurement of water levels in existing vadose zone monitoring wells.

4. Measurements of soil moisture tension from new tensiometers.

5. Collection and analysis of interbed sediment samples at locations of new tensiometers for development of moisture characteristic curves and grain size analysis.

6. Collection and chemical analysis for COCs in groundwater samples from new and existing monitoring wells installed in the SRPA.

7. Collection and chemical analysis of tracers in perched water. Measurement of water levels in new and existing monitoring wells installed in the SRPA.

8. Recharge water source information obtained from outside sources for precipitation. Big Lost River flows, and facility discharge volumes.

9. Incorporation of monitoring data, collected during the 5 years following relocation of the percolation pond, into a refined WAG-3 OU 3-13 model and calculation of the predicted concentrations of COC in the SRPA in year 2095 and beyond.

3.1.3.3 Inputs for PSQ-2. The inputs to PSQ-2 will be the answers to PSQ-1a and PSQ-1b. Both PSQ-1a and PSQ-1b will have either a "yes" or "no" answer. No additional field data is required for PSQ-2.

3.1.3.4 Inputs for PSQ-3. If additional recharge controls are deemed necessary, the determination of which recharge controls will be most effective to reduce COC transport will require an understanding of the distribution of water from each of the potential recharge sources. Knowing the source(s) of water collected in each monitoring well will help to determine which recharge source(s) are affecting which areas of the subsurface and help to focus recharge controls on those sources which have the greatest impact on the areas of concern. This can be accomplished through the correlation of head changes in the vadose zone to periodic changes in the various recharge sources and through a geochemistry study, to directly relate waters collected at the various vadose zone monitoring wells to recharge sources.

Beyond what is called for under PSQ-1a and PSQ-1b, no additional field data needs to be collected to correlate head changes in the subsurface to changes in recharge sources. The planned monitoring equipment will provide sufficient monitoring of water levels and tensions distributed throughout the subsurface at INTEC. However, information regarding changes in the recharge sources will need to be obtained from outside programs. BLR flows at the Lincoln Blvd. bridge near INTEC will be obtained from the USGS. Temperature and precipitation data will be obtained from the National Oceanic and Atmospheric Administration (NOAA) monitoring station at the Central Facilities Area. Operating data from the percolation ponds, sanitary treatment infiltration galleries, and other potential recharge sources will be obtained from INTEC facility operations.

The geochemical evaluation of recharge sources will require the collection and analysis of both the source recharge waters and vadose zone waters from the monitoring network. These samples will be analyzed for basic geochemistry (cations, anions), isotopic ratios, and chemicals that can be specifically traced to an individual recharge source (i.e., nitrates to sewage plant and tank farm, and chloride to percolation ponds).

Therefore, the inputs to PSQ-3 are

1. Time-series water level and tension measurements in existing monitoring wells and in the Phase I and II wells.

2. Time-series data obtained from NOAA, USGS, and INTEC operations for information impacting recharge including BLR flow data, precipitation, temperature, barometric pressure records; and discharge volumes to the percolation ponds, sanitary treatment infiltration galleries and other operational discharges.

3. Perched water sample collection and analysis for tracers.

4. Perched water sample collection and analysis for basic geochemistry, (e.g., major cations and anions) isotopes (e.g., N^{14}/N^{15} ratios, chlorine-36), and source or recharge indicator chemicals, (e.g., nitrates, caffeine, chloride).

5. Collection and analysis of source term waters for the same suite of analytes as groundwater samples.

3.1.4 Define the Boundaries of the Study

This study focuses the transport of COCs from the vadose zone to the SRPA. Specifically excluded from this study is contamination of the surface soils (alluvium to top of basalt) at INTEC which are covered under other programs. The physical boundaries of the study area are from the BLR on the north to the percolation ponds at the south end of INTEC. The east-west boundaries roughly correspond to the east-west perched water zones and include the sewage treatment lagoons and probably a portion of the BLR. At depth, the boundaries of the study area are from the base of alluvium basalt down and into the top of the SRPA.

To aid in the remedial action evaluation and based on the physical characteristics of the perched water bodies and locations of recharge sources, the vadose zone will be divided into a northern-upper, northern-lower, southern-upper, and southern lower perched water zones. The boundary between north and south will be marked by an east-west line across the southern end of the FAST building (CPP-666). The boundary between the upper and lower perched water is placed at a depth of 200 ft between what is commonly referred to as the upper interbeds 33.5 to 42.7 m (110 to140 ft) and lower interbeds 115.8 m (~380 ft). The division of the vadose zone into four discrete study areas allows for independent review of each of these areas as the remedial action progresses. The tracer test data will be used to determine the connectivity between the perched water zones for compliance monitoring.

The Group 4 remedial activities will be undertaken in two phases. The purpose of the first phase is to obtain information and background data while the percolation ponds are in use to establish compliance monitoring and will include installation of nine wells (three sets of three wells each), conducting tracer tests, and monitoring moisture content and COC concentrations. The purpose of Phase II is to monitor the drain out of the perched water following relocation of the percolation ponds and will include drilling additional wells.

Lining of the BLR will require compliance with additional applicable or relevant and appropriate requirements such as National Environmental Policy Act (NEPA), and 40 CFR 230.404(B)(1), "Guidelines for Specification of Disposal Sites For Dredged or Fill Material," modification to the Statement of Work. This may lead to additional field investigations to support an explanation of significant differences or ROD amendment.

3.1.5 Develop a Decision Rule

This step of the DQO process brings together the outputs from steps 1 through 4 into a single statement describing the basis for choosing among the listed alternatives.

DR-1a: If, after five years following percolation pond relocation, the mean soil moisture content in the vadose zone sections (e.g., north-shallow, north-deep, south-shallow, and south-deep) is equal to or less than the mean soil moisture tension predicted by the refined WAG-3, OU 3-13 vadose zone model, then we can conclude that we have met the first remediation goal for Group 4.

DR-1b: If, following the five years of environmental monitoring and incorporation of those data into the refined WAG-3, OU 3-13 model, we predict through modeling that concentrations of COCs in the SRPA will be equal to or less than applicable MCLs or RGs in the year 2095 and beyond, then we can conclude that we have met the second remediation goal for Group 4.

DR-2: If we conclude that both remediation goals have been met based upon DR-1a and DR-1b above, then we can conclude that the perched water RAO has been met and additional recharge controls are not required. If we conclude that either of the remediation goals, DR-1a or DR-1b, has not been met, then the RAO has not been met. Therefore, per the ROD (DOE-ID 1999, Section 8.1.4, p 8-10) the contingency for limiting recharge from the BLR must be implemented.

DR-3: If new data collected during the 5 years of monitoring indicate that the BLR is not a significant source of recharge to the vadose zone, then a ROD modification will be done and other recharge source(s) addressed.

3.1.6 Specify Tolerable Limits on Decision Errors

This step of the DQO process sets out the acceptable limits on decision error. These limits are used to establish performance goals for the data collection design.

The average soil tension measurement in each of the zones will be compared to the action levels established under PSQ-1a and PSQ-1b for each zone. COC flux concentrations will be compared to MCL or RG values and established action levels.

When data can be statistically manipulated, hypothesis testing will be utilized to determine if the action level is exceeded in any of the zones. The recommended null hypothesis, H_0, is that the true mean in each zone is greater than the action level. The alternative hypothesis is that the mean is less than or equal to the action level:

H_0: $\mu >$ Action Level

H_a: $\mu \leq$ Action Level

The hypothesis testing will be based upon small sample statistics ($n < 30$) and utilize the t test statistic:

$$\text{Test Statistic: } t = \frac{\bar{x} - hypothesized\ value}{s/\sqrt{n}}$$

where:

t	=	critical test statistic
$\bar{x}$	=	mean moisture content
s	=	standard deviation, and
n	=	the number of samples.

Using this test statistic and hypothesis, we would reject the null hypothesis (and thereby accept the alternative hypothesis) if the test statistic t is less than the negative value of the t critical value obtained from standard statistical tables given our number of samples and desired level of significance.

The proposed hypothesis testing is designed to allow for control of the probability of erroneously concluding that COC action levels are not exceeded when in fact they are exceeded. This null hypothesis was formulated based upon the belief that the harmful consequences of incorrectly concluding that an action level is not exceeded when it actually is exceeded out weigh the consequences of incorrectly concluding that the action level is exceeded when in fact it is not.

In the case where decisions will be made by comparing data to computer predictions, the accuracy of the computer predictions will be bounded by the accuracy of the OU 3-13 model.

3.1.7 Optimize the Design

The design for the OU 3-13 Group 4 investigation will be implemented in phases. These phases will build on each other, allowing the design of the monitoring program to be optimized through a full understanding of site conditions. The tasks for Phases I and II are described below.

3.1.7.1 Phase I Activities. Phase I includes installation of five well sets to be drilled prior to conducting the tracer test. Vadose zone well sets will be located south of the BLR, west of the sewage treatment lagoons, on the northwest corner of the tank farm perimeter, in a location central of the INTEC facility and north of the existing percolation ponds. Phase I well sets include a combination of alluvial wells with instrumentation installed at about 13.7 m (45 ft bgs), upper perched water well with instrumentation installed at about 36.6 to 42.7 m (120 to 140 ft bgs), lower perched water well with instrumentation installed at about 115.8 m (380 to 420 ft), and aquifer well at about 460 ft. The justification for each Phase I well set follows.

- **Big Lost River Well Set.** This well set is located south of the BLR. The alluvial well will provide a location for sampling any perched water that develops in the alluvium as a result of flow in the BLR. The upper and lower perched water wells will provide locations for sampling the perched water zones in the northern INTEC area. The site for this set is a location near the BLR where monitoring wells currently do not exist. These wells will serve as the monitoring points for the BLR tracer (and indicator parameters, should they be present). Wells at this location will help define the northern boundary and vertical extent of the perched water zones and will help identify the hydraulic connection between the river and the perched water zones.

- **Sewage Treatment Lagoon Well Set.** This site for this set is southwest of the sewage treatment lagoons. The well set will provide sampling locations in the northeastern portion of INTEC in the alluvium (to evaluate perched water presence in the alluvium as result of flow in the BLR or discharge from the sewage treatment lagoon) and in the upper and lower perched water. The site is near the sewage treatment lagoons where no monitoring wells in the perched zones currently exist. This well set will serve as the alluvium/basalt interface, upper, and lower perched water-monitoring points for the tracers and indicator parameters. The wells at this location will help define the vertical depth and the thickness of the perched water zones in this area. The wells will also provide information on the hydraulic connection between the river, the sewage treatment lagoons, and the perched water zones, thereby reducing uncertainty to aid with meeting RAOs.

- **Percolation Pond Well Set.** This well set will provide a location for sampling perched water that has developed in the alluvium and in the upper and lower perched water as a result of wastewater disposal in the percolation ponds. The wells will be placed north of the percolation ponds at a location where no monitoring wells in the alluvium currently exist. (Upper perched water wells exist to the north and south, and one lower perched water well exists to the north.) This well set will serve as monitoring points for the tracer introduced into the percolation ponds (and indicator parameters, should they be present). The wells will help identify the locations and vertical depth of the perched water and provide information on the hydraulic connection between the percolation ponds and the perched water zones.

- **Tank Farm Well Set.** This well set will be located on the northwest corner of the tank farm (see Figure 4-1) and will include four wells: alluvium, upper perched water, lower perched water, and aquifer skimmer. The location for this well set was selected to provide a monitoring point between the BLR and the tank farm and to access contaminated water that might move to the northwest from the tank farm. These wells will help define effects of the BLR flow on the perched water at the alluvium/basalt interface, in both perched water zones, and in the SRPA.

- **Central Well Set**. This well set is located in a central location between the north and south perched water bodies (see Figure 4-1). The cluster will monitor the shallow perched water and deep perched water zones. As nearby perched water wells (MW-11, MW-11P) have been dry at recent measurement events, the tensiometer and lysimeter data collected from this location should provide valuable information.

Instrumentation in Phase I wells will include a piezometer, deep tensiometers (to measure soil tension), suction lysimeters (for collecting water samples), and possibly soil moisture sensors. The piezometer will be installed in the borehole at the primary perched water zone. The suction lysimeters will be installed in the primary perching zone and other "wet" zones. A suction lysimeter will also be placed in the well at the primary perched water zone to determine contaminate concentrations for flux calculations following perched water drain-out. The data may be used to determine contamination or recharge sources. If the moisture sensors can be successfully installed, field scale moisture characteristic curves will be developed.

In Phase I, a unique tracer will be added to each of the major recharge sources: existing percolation ponds, sewage treatment lagoons, and the BLR, as discussed in the Tracer Test Plan (Appendix D). During the tracer test, perched water will be sampled and analyzed for tracer concentrations, and if necessary, other chemical and isotopic ratios to augment the tracer data. Tracer data will then be used to determine the extent of perched water, the impact and interconnectivity of each recharge source on perched water, and to refine the conceptual and WAG-3 OU 3-13 numerical models.

Phase I will also include collecting soil moisture tension data from the Phase I perched water wells, collecting water samples from lysimeters in newly installed and existing perched water wells and analyzing data for COCs and water geochemistry. COC analytes include tritium, technicium-99, iodine-129, strontium-90, plutonium isotopes (Pu-238, -239, -240, -241) uranium isotopes (U-234, -235, -238), neptunium-237, cesium-137, and mercury. In addition to the COCs listed in the ROD sewage and other hazardous constituents will be initially analyzed for and include 1,1,1-TCA, carbon tetrachloride, TCE, PCE, benzene, toluene, and carbon disulfide. Several stable isotopic ratios will be evaluated along with the constituents listed above if an independent research project receives funding. The isotopic ratios of nitrogen, oxygen, strontium, and hydrogen have been identified for this research. Final notification of funding will be made near the end of FY-00. Water level data will also be collected from existing INTEC perched water wells.

Phase I findings will provide information on the extent and mixing of the perched waters from the "major" recharge sources. Additional wells may be installed in Phase II. The locations of the additional wells will be determined by input from the following criteria: (1) tracer test results, (2) proximity to recharge sources, (3) proximity to potential contamination sources, and (4) representation of the INTEC perched water.

3.1.7.2 Phase II Activities. Phase II involves installing additional well sets, each of which may include an alluvial well (~45 ft bgs), a shallow perched water well (~120 to 140 ft bgs), a deep perched water well (~380 ft bgs), and an aquifer skimmer (screened across the water table) well (~450 ft bgs).

Phase II will also include installing monitoring instrumentation similar to that in Phase I, monitoring water levels in all existing perched water wells, and COC and geochemical sampling of soil and perched water in new and existing wells. COCs, including any additional hazardous substances, will be sampled for annually during Phase I and II until the decision on the need for further recharge control is made (more than five years after the relocation of the percolation ponds). Sampling frequency, analytes, sampling locations, following the decision on further recharge controls, will be determined using the results of the Phase I and Phase II monitoring. Geochemistry samples will be collected initially (after completion of Phase I wells) and in years 2, 4, and 6 (assuming percolation ponds will be relocated in year 2).

Sampling and monitoring of the vadose zone wells will continue during the five years after percolation pond removal. It is estimated that a network of 60 wells will be sampled annually for chemical analysis during Phase II. Moisture data from the same well network will also be collected daily during this phase. Following the completion of the initial five years of Phase II monitoring and completion of the Monitoring Report/Decision Summary for contingent remediation, it is expected that if the drain-out is occurring as predicted, the monitoring well network and sampling frequency will be reduced. The Monitoring Report/Decision Summary will present the subsequent monitoring plan for the period following the initial five years of Phase II monitoring.

3.2 Sampling Objectives

Sampling objectives have been determined through the careful evaluation of existing data and the application of the data quality objective process. This process has lead to the development of data requirements needed to support defining extent of perched zones, source water estimation, fate and transport (flux) evaluation and modeling. The proposed location of each well set was chosen for one or more of the following reasons: (1) to define inputs from recharge sources, (2) define lateral extent of perched zones, and (3) to provide vadose zone information in areas where little or no previous information is available.

The primary purpose of the vadose zone wells is to define perched water zone extent, and measure the drain out/recharge of perched water bodies beneath the INTEC facility. Existing wells will be used to the extent practical, based on their location and construction. Existing wells will primarily be used to define perched zone extent and monitor drain out/recharge. Secondary information to be gained from the new wells is undisturbed interbed material for geotechnical analysis, and water samples for contaminant concentration for use in contaminant flux calculations.

3.3 Data Reporting

Results of the Phase I and Phase II drilling activities will be presented in separate well drilling reports. These reports will include lithologic descriptions, updated cross-sections of the INTEC, geophysical well logs, well construction diagrams, as-built drawings of instrumentation installations, summaries of analytical (physical and chemical) results, and copies of the field notes.